drums. Penetrations were within drum disposal areas at the extreme northern and southern ends of Pad A. A mobile fabric structure was constructed over the penetration sites to provide protection from the elements and to control the spread of contaminants.

In December 1989, eight drums were uncovered at the southern end of Pad A. Drum surfaces in direct contact with the plywood covering were badly corroded, as Figure 3-8 shows. All of the exposed drums showed signs of corrosion, and six of the eight drums were corroded through; the observed holes ranged from pinholes to 10.2 cm (4 in.) in diameter. Smear samples did not show radioactive contamination on drum surfaces, nor was airborne alpha or beta contamination detected by continuous air monitors. Operational safety requirements prevented removing the breached drums to sample waste; however, a single drum was removed on January 8, 1990, and subsequently sampled to support demonstrations of in situ and ex situ treatment of Series 745 evaporator salts (see Figure 3-9). Chemical and radioisotope analyses for the retrieved Series 745 salts were consistent with Rocky Flats Plant process knowledge (Halford et al. 1993).

Figure 3-8. Drums exposed on Pad A during the Initial Penetration Project.

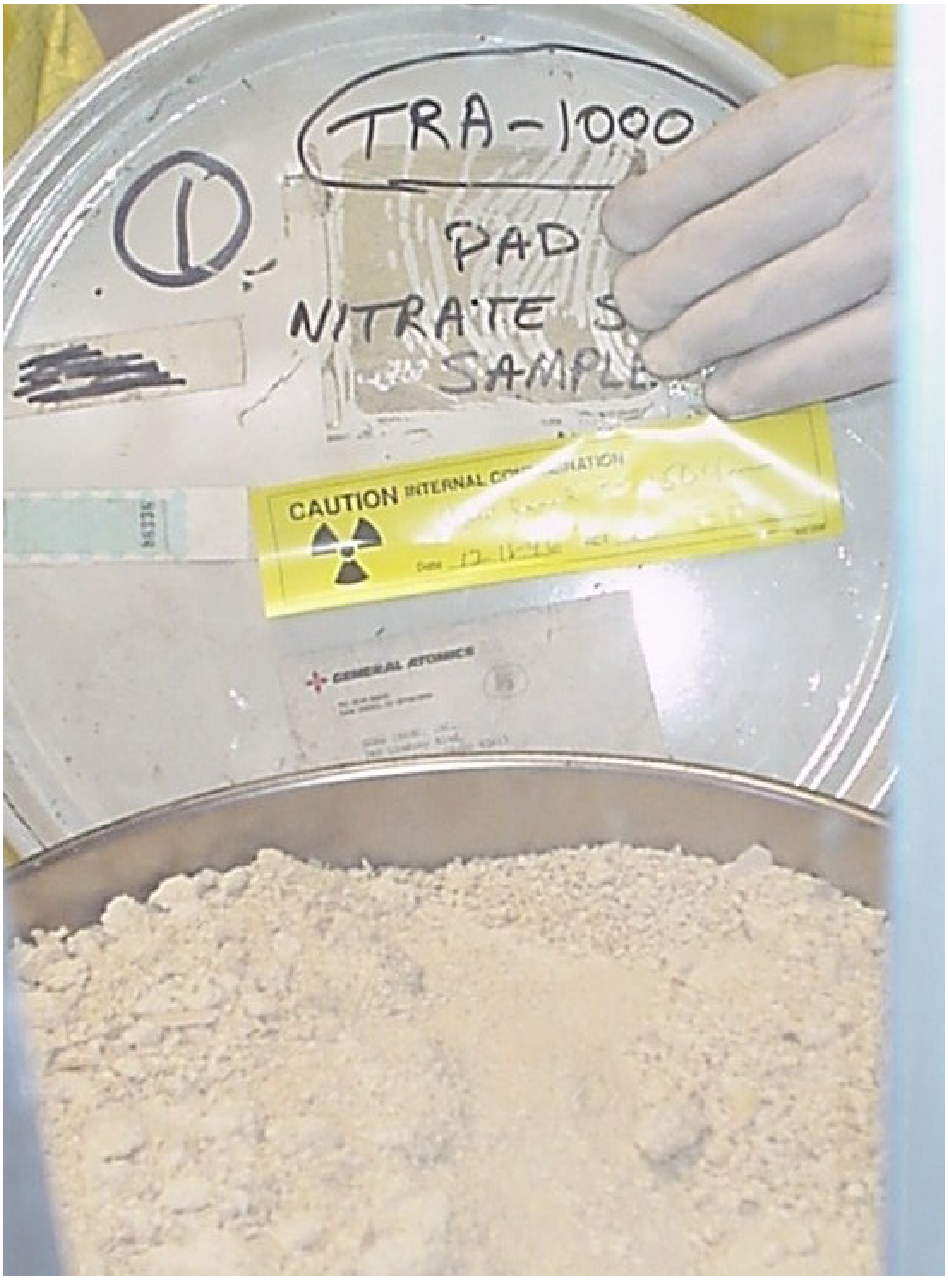


Figure 3-9. Series 745 evaporator salts retrieved during the Pad A Initial Penetration Project.

***3.1.5.6 Operable Unit 7-10 Glovebox Excavator Method Project.*** The Operable Unit 7-10 Glovebox Excavator Method Project was chartered to demonstrate retrieval, characterization, and interim storage of TRU waste from a selected portion of Operable Unit 7-10, which comprises Pit 9 within the SDA. Pit 9 contains TRU waste from Rocky Flats Plant and radioactive waste generated at the INL Site. Waste was buried in Pit 9 from November 8, 1967, through June 9, 1969. Drums were dumped randomly from cargo containers, and many containers were damaged at that time. Containers also were damaged by heavy equipment used to reposition waste and cover it with soil overburden. In addition, the pit was flooded during the 1969 spring snowmelt (see Figure 3-10); therefore, it was assumed that buried drums would be highly corroded and that drum contents would readily disperse when excavated.

Figure 3-10. Flooding in Pit 9 during the spring 1969 snowmelt flooding event.

The retrieval approach of the Operable Unit 7-10 Glovebox Excavator Method Project was developed on recognition (DOE-ID 1998a) that the retrieval design identified in the Pit 9 ROD (DOE-ID 1993) could not meet enforceable milestones for completing Stage II retrieval activities. Several alternative concepts were developed (INEEL 2001), resulting in identification of the glove box excavator method alternative as the preferred retrieval method (DOE-ID 2002).

The original Pit 9 Stage II design included a large excavation confinement structure, with a rail-mounted remote excavator, to maintain primary and secondary containment of airborne contaminants. The glove box excavator method simplified this technical approach by using a much smaller Retrieval Confinement Structure (see Figure 3-11) where only the arm of the excavator penetrated the confinement structure, while the excavator chassis remained outside the confinement structure (see Figure 3-12). This approach not only limited worker entry into the Retrieval Confinement Structure for excavator maintenance, but also allowed the retrieval schedule for Stage II to accelerate. Retrieved waste was sorted, segregated, and packaged in three packaging glove box system units, which were directly attached to the Retrieval Confinement Structure. The entire work space was enclosed within the large Weather Enclosure Structure, which provided secondary containment. The facility ventilation system maintained a negative pressure between outside and the Weather Enclosure Structure, and a further pressure drop between the Weather Enclosure Structure and the Retrieval Confinement Structure, thus reducing the potential for worker contamination. All exhaust air from the Retrieval Confinement Structure passed through HEPA filters before discharging to the atmosphere.

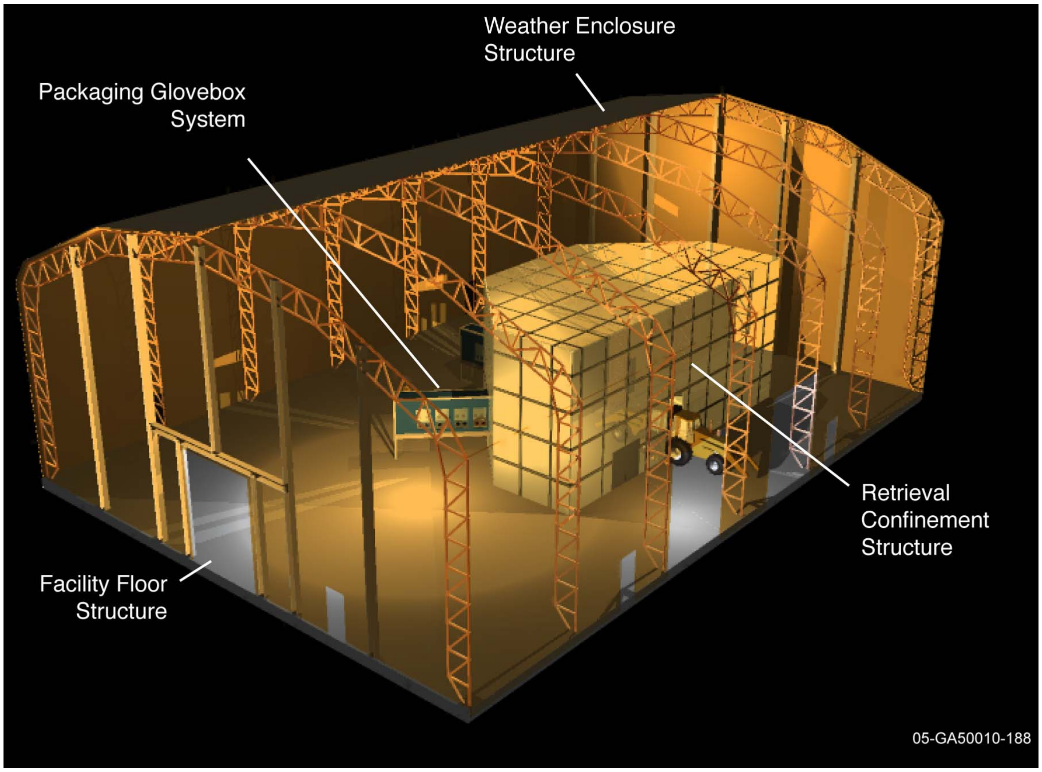


Figure 3-11. Operable Unit 7-10 Glovebox Excavator Method Project facility.


Figure 3-12. Operable Unit 7-10 Glovebox Excavator Method Project excavator interface with the Retrieval Confinement Structure.

The Pit 9 Agreement to Resolve Disputes (DOE 2002) required retrieving from the waste zone from 57 to 96 $m^3$ (75 to 125 $yd^3$) of buried material having a high content of TRU radionuclides. With agreement from DEQ and EPA, DOE-ID selected the retrieval location, based on detailed evaluation of records identifying waste type, contaminant inventory, and disposal location, as well as the results of in situ probehole logging (see Section 3.6.4) and geophysical surveys (Anderson 2002; Jamison and Preussner 2002). Probehole logging had identified a suspected large plutonium mass within the proposed excavation area; this greatly increased the potential for generating high levels of airborne contamination during excavation activities.

Top-level objectives for the Operable Unit 7-10 Glovebox Excavator Method Project included:

- Demonstrating waste zone material retrieval, including buried TRU waste
- Providing information on contaminants of concern present in the underburden
- Characterizing waste zone material for safe and compliant storage
- Packaging and storing waste zone material on the INL Site, pending a decision on final disposition.

Waste drums observed during the Operable Unit 7-10 Glovebox Excavator Method Project excavation had little structural integrity due to corrosion, and were readily disrupted using the excavator bucket or hand tools within the packaging glove boxes. However, plastic drum liners and bottles found within the drums were in good to excellent condition, and generally were effective in containing the drum contents when found intact (see Section 5.1.2 about applying this information to the RI/BRA). Some free liquid was observed during retrieval and waste packaging operations. In most cases, free liquid was absorbed by the adjacent soil. All retrieved waste was visually examined to exclude noncompliant items. Drum labels protected by plastic film were clear and legible. No classified waste was observed during retrieval. Suspect waste forms were assayed using a fissile material monitor to ensure safe storage of packaged waste. Waste drums were placed in RCRA-compliant storage in WMF-628 pending final waste characterization and disposition.

Waste retrieval operations commenced on January 5, 2004, and were terminated on February 21, 2004 (DOE-ID 2004a), when a total of 454 drums containing approximately 57 $m^3$ (75 $yd^3$) of potentially contaminated media had been retrieved and packaged. Approximately 42% (i.e., 192 of 454, at a $1\sigma$ confidence level) of all waste drums were provisionally identified to contain TRU isotopes measuring higher than 100 nCi/g. However, it is unlikely that more than 13% (i.e., 60 of 454) of these will be identified as TRU waste when characterized using WIPP-compliant assay procedures.

Composite and bias samples of homogeneous waste and interstitial soil were collected during Operable Unit 7-10 Glovebox Excavator Method Project retrieval operations (DOE-ID 2004a; Salomon et al. 2003). One group of samples was used to confirm waste codes used for RCRA-compliant storage of drummed waste. Composited waste samples also were analyzed for polychlorinated biphenyls and found to contain less than the Toxic Substances Control Act (15 USC § 2601 et seq., 1976) regulatory limit of 50 mg/kg. Five samples of presumptive underburden were collected by coring after removing overlying waste. Underburden sampling was complicated by mixing waste and adjacent soil during excavation. A clear differentiation between the waste zone and underburden was not observed. Underburden samples were analyzed for radionuclide content, VOCs, and soluble ions. Though some underburden subsamples were contaminated with high levels of TRU isotopes, interpreting these data was complicated by evidence of waste having been mixed with the underburden (DOE-ID 2004a, Appendix F). Additional soil and waste samples were collected to support waste characterization and preremedial design bench-scale tests (see Section 3.9) (Salomon et al. 2003).

Late in the Operable Unit 7-10 Glovebox Excavator Method Project, a drum containing several polyethylene jars of scarfings (i.e., graphite fines scraped from molds used for plutonium casting) was uncovered at the P9-20 probe position. Figure 3-13 shows the probe at Location P9-20 piercing the drum containing the scarfings jars. One of these jars was intentionally ruptured at the bottom of the excavation to establish a bounding estimate for airborne radioactive contamination that might be experienced during future retrieval efforts (Horne 2004; DOE-ID 2004a). Analysis of interstitial soil samples retrieved after the scarfings jar was ruptured suggests that the surrounding soil became highly contaminated from dispersal of the graphite fines. Tests defining leaching and operational speciation of TRU isotopes associated with these soil samples suggest that contaminants in graphite fines are relatively resistant to transport by infiltrating groundwater (see Section 3.8) (Groenewold et al. 2005).


Figure 3-13. Probe at Location P9-20 penetrating dumped waste drums within the Operable Unit 7-10 Glovebox Excavator Method Project retrieval area.

On completion of waste retrieval and sampling operations, the Operable Unit 7-10 Glovebox Excavator Method Project facility was prepared for warm standby in anticipation that the facility might be used during the Accelerated Retrieval Project. Probes previously used for in situ logging either were removed and laid down in the excavation or cut off. Exposed surfaces within the Retrieval Confinement Structure and Packaging Glovebox System were swept and vacuumed. The excavation then was filled with two lifts of a low-strength cementitious grout. All nonessential systems were shut down following grouting. The project generated less than 2.2 $m^3$ of secondary waste, including that associated with facility deactivation.

The Operable Unit 7-10 Glovebox Excavator Method Project was completed at a total project cost, excluding future decommissioning and demolition, of $67.4 million (DOE-ID 2004a).

***3.1.5.7 Accelerated Retrieval Project.*** The Accelerated Retrieval Project is a CERCLA non-time-critical removal action focusing on limited excavation and retrieval of selected waste streams from a designated portion of the SDA. The Accelerated Retrieval Project Engineering Evaluation/Cost Analysis (DOE-ID 2004b) identifies focused retrieval as the recommended alternative for implementing the removal action. Several changes were adopted as a result of public comments on the analysis (e.g., sampling nontargeted waste to assess efficacy of removing targeted waste, based on visual criteria).

The primary purpose of the Accelerated Retrieval Project removal action was to remove waste with high concentrations (relative to other locations in the landfill) of TRU radioisotopes from a portion of the SDA. The removal action was expected to contribute to efficient performance of any anticipated long-term remedial action specified in the future Operable Unit 7-13/14 ROD for final closure of the SDA. Removing targeted Rocky Flats Plant waste significantly reduces the amount of TRU radionuclides and uranium isotopes within the described area. In addition, the removal action was expected to provide characterization, technical, and cost information from full-scale waste retrieval activities to support preparation of the Operable Unit 7-13/14 RI/FS.

The described area for the Accelerated Retrieval Project removal action was selected by DOE-ID, with concurrence of DEQ and EPA, based on detailed evaluation of records identifying waste type, contaminant inventory, and disposal location (Bryan and Anderson 2005). Rocky Flats Plant waste types targeted for removal during the removal action (DOE-ID 2004c) include the following:

- Series 741 waste water treatment sludge (886 drums)
- Series 743 organic setup sludge (638 drums)
- Uranium roaster oxide waste (109 drums)
- Graphite (49 drums)
- HEPA filters (681 boxes or cartons).

The Action Memorandum (DOE-ID 2004c) also states:

> It is possible that during the process of excavation other waste will be revealed that is not within these targeted waste streams. This nontargeted waste will also be removed from the excavation during this removal action if the DOE remedial project manager and the EPA and DEQ Waste Area Group 7 remedial project managers agree that retrieval is warranted because the information concerning the nontargeted waste that is available from visual inspection (such as package labeling or distinctive packaging) identifies the nontargeted waste as being of a nature that (1) it poses a potential risk of contamination to the underlying aquifer if left in place; (2) the potential risk is sufficient to warrant removal at that time rather than leaving it to be addressed by the OU 7-13/14 final remedial action for WAG 7; and (3) the waste can safely be managed by retrieval using the personnel, facilities, and equipment readily available onsite for retrieval of the targeted waste streams.

The Accelerated Retrieval Project retrieval area, located in the eastern portion of Pit 4, was approximately 0.2 ha (1/2 acre) in area with a footprint of 33.5 × 16.6 m (110 × 202 ft). The described area represents approximately 21% of Pit 4. Pit 4 was open to receive waste from January 3, 1963, through September 26, 1967. Waste buried in this area was primarily from Rocky Flats Plant. Records of past waste disposal practices suggest that most of the waste buried in the described area was dumped, rather than stacked within the pit. Subsequent use of heavy earth-moving equipment for waste leveling and overburden placement is thought to have caused significant damage to waste containers. Based on observations made during the Operable Unit 7-10 Glovebox Excavator Method Project, most drums in the retrieval area were assumed to be highly corroded and likely to be breached.

The Accelerated Retrieval Project removal action took place in a relocatable Retrieval Enclosure that incorporated separate airlocks for equipment service and waste packaging (see Figure 3-14). Overburden was removed and waste was retrieved using a manned excavator equipped with a sealed cab that was pressurized with HEPA-filtered air (see Figure 3-15). Waste retrieved during the Accelerated Retrieval Project removal action was repackaged in new containers, placed in interim storage, and characterized for disposal at WIPP. Retrieved waste that did not satisfy WIPP waste acceptance criteria (e.g., non-TRU waste) was characterized to determine appropriate treatment and disposal options.

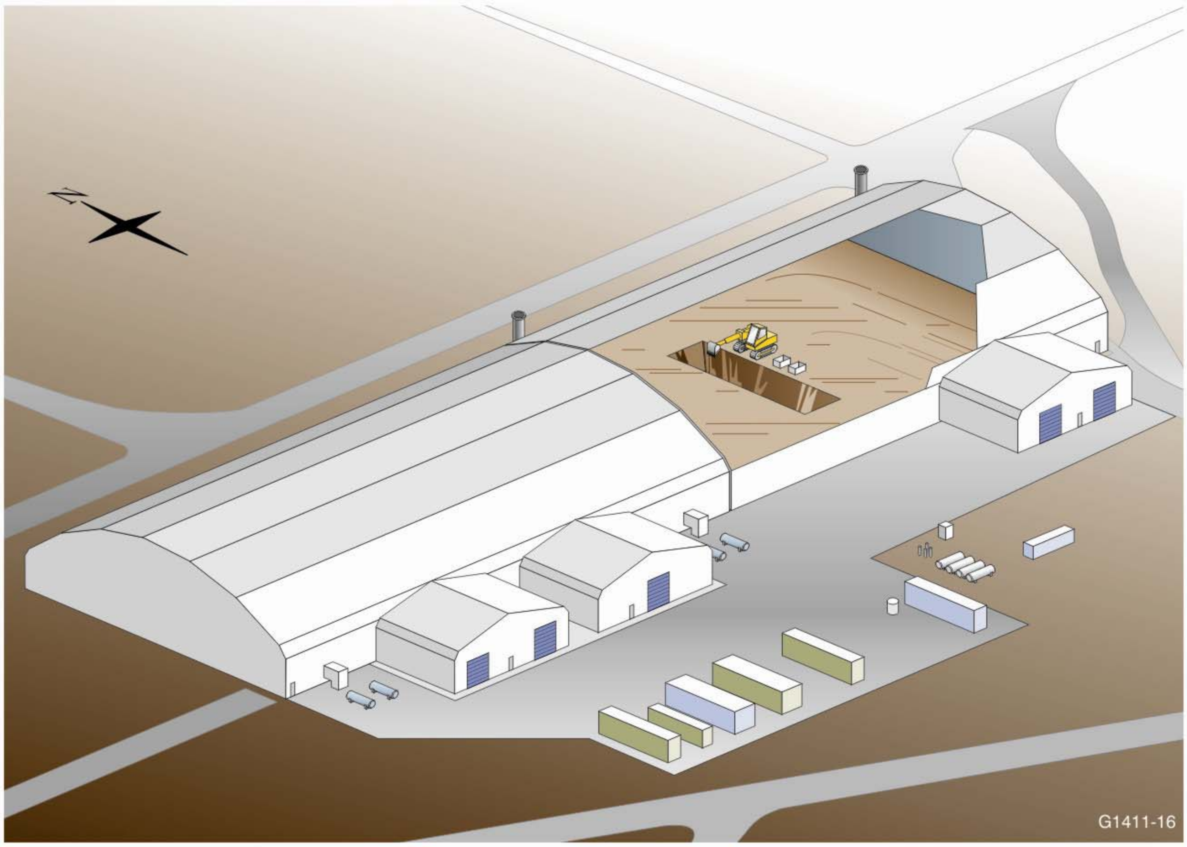


Figure 3-14. Accelerated Retrieval Project Retrieval Enclosure (solid roof), attached equipment-service and waste-handling airlocks, and planned expansion (cut-out roof).


Figure 3-15. Accelerated Retrieval Project excavator retrieving waste from Pit 4.

Visual inspection was proposed as the primary means to identify waste targeted for retrieval and subsequent disposition during the Accelerated Retrieval Project removal action. Targeted and nontargeted types of waste were segregated within the excavation; nontargeted waste was not to be retrieved. However, nontargeted waste might have been retrieved if DOE, DEQ, and EPA remedial project managers agreed that removal was warranted, based on visual identification criteria. Targeted waste was packaged in new 55-gal drums and assayed to ensure criticality safety during interim storage. Compliant drums were transferred to an interim storage facility to await additional characterization required to complete WIPP TRU waste certification. Following completion of the removal action, interim closure will be implemented by backfilling the excavation with previously removed overburden and covering the area with a layer of compacted soil. Final closure of the described area will be addressed in the Operable Unit 7-13/14 ROD.

Major work activities for the Accelerated Retrieval Project removal action include the following:

- Remove clean overburden
- Erect the Retrieval Enclosure and support facilities
- Excavate potentially contaminated overburden
- Excavate waste zone material and retrieve targeted waste
- Visually examine retrieved waste and waste packaging
- Sample waste zone material to meet WIPP RCRA certification requirements
- Perform nondestructive assay of drummed waste to ensure safe storage
- Interim store drummed waste under CERCLA

- Perform nondestructive assay to meet WIPP TRU waste certification requirements
- Collect headspace-gas samples of TRU waste
- Perform gas generation testing of TRU drums that failed headspace-gas sampling
- Treat TRU drums that failed gas-generation testing, if required
- Package TRU waste loaded into TRUPACT (i.e., transuranic package transporter) II containers for transport to WIPP
- Treat and dispose of any retrieved waste determined not eligible for disposal at WIPP.

Removal of targeted waste from the Accelerated Retrieval Project was initiated on January 13, 2005. By April 30, 2005, a 4.6 × 41-m (15 × 135-ft) area had been excavated down to the underburden (approximately 18 ft below grade) in the western end of the described area. A total of 284 drums of targeted waste were visually inspected, packaged, and assayed for safe storage, which equates to removing approximately 39.8 $m^3$ of targeted waste. In addition, approximately 300 unopened drums remained within the Retrieval Enclosure on May 1, 2005, when work was temporarily suspended to transition to Idaho Cleanup Project contractors. (Work resumed July 15, 2005, and is ongoing, as described in Section 3.1.6.)

Waste drums observed during excavation of the western end of the Accelerated Retrieval Project described area had been stacked in good order and exhibited good structural integrity (see Figure 3-16). The integrity of these drums was not anticipated because of the degraded condition of drums observed during the Operable Unit 7-10 Glovebox Excavator Method Project. Information from one label enabled clear identification of a Rocky Flats Plant waste shipment record for one drum. These observations were used to estimate burial location errors in the western end of Pit 4 (White 2005).


Figure 3-16. Orderly stacked waste drums at the western end of the Accelerated Retrieval Project retrieval area.

The original estimated cost for the Accelerated Retrieval Project removal action is approximately \$208.5 million (DOE-ID 2004b) to cover design; construction; operations; deactivation, decontamination, and decommissioning; certification of waste for shipment to WIPP; disposition of secondary waste; and interim closure.

***3.1.5.8 Accelerated Retrieval Project II.*** An engineering evaluation and cost analysis for expanding the Accelerated Retrieval Project non-time-critical removal action was published for public comment in March 2005 (DOE-ID 2005b). The Accelerated Retrieval Project II includes constructing an extension to the eastern end of the original Retrieval Enclosure (see Figure 3-14). The additional retrieval area measures approximately 75.6 × 38.4 m (248 × 126 ft), and encompasses the eastern end of Pit 4 and the western end of Pit 6; this area received many waste drums containing Series 743 organic setup sludge from Rocky Flats Plant. The DOE-ID, with DEQ and EPA concurrence, selected the designated portions of Pits 4 and 6, based on their high content of targeted waste. A storage enclosure to temporarily store retrieved waste will be constructed north of the retrieval area between Pad A and Pit 3. The foundation has been constructed. The storage enclosure is a commercially available, standard fabric structure approximately 39.6 m (130 ft) wide and 48.8 m (160 ft) long.

Waste types targeted for removal during the Accelerated Retrieval Project II removal action are identical to those identified for the initial removal action (Bryan 2005; DOE-ID 2005b) and include the following:

- Series 741 waste water treatment sludge (equivalent to 646 new drums)
- Series 743 organic setup sludge (equivalent to 3,750 drums)
- Series 744 special setup sludge (equivalent to 374 drums)
- Uranium roaster oxide waste (equivalent to 210 drums)
- Graphite (equivalent to four drums)
- HEPA filters (equivalent to 867 drums).

The technical approach for the proposed Accelerated Retrieval Project II removal action is identical to that used for the initial removal action. The proposed approach uses the original equipment-service and waste-packaging airlocks.

The original estimated cost for the Accelerated Retrieval Project II removal action is approximately \$181.5 million, which includes design; construction; operations; deactivation, decontamination, and decommissioning; certification of waste for shipment to WIPP; disposition of secondary waste; and interim closure (DOE-ID 2005b).

***3.1.5.9 Targeted Waste Removal and Disposition Retrieval Concept.*** On March 24, 2005, DOE announced selection of CH2M-WG Idaho, LLC, as the contractor responsible for the Idaho Cleanup Project through the year 2012. In addition, on February 9, 2005, DOE modified the contract for the Advanced Mixed Waste Treatment Project at the INL Site, which resulted in reassigning resources from the Accelerated Retrieval Project removal action to the Advanced Mixed Waste Treatment Project to meet a key milestone under the 1995 Settlement Agreement (DOE 1995). The Accelerated Retrieval Project facility remained in warm standby from May 1, 2005, through July 14, 2005, when the project was notified to resume work. During warm standby, CH2M-WG Idaho, LLC, extensively reviewed the safety basis, operating procedures, and operations history for the Accelerated Retrieval Project.

Lessons learned so far from limited Accelerated Retrieval Project excavation operations include the following:

- In-pit waste segregation was complicated by difficulty in emptying drums exhibiting good integrity
- Some types of waste generated high radiation fields
- Visual discrimination between inorganic (e.g., waste water treatment) sludge and organic setup sludge was difficult
- Visual discrimination between Series 741 and 742 waste water treatment sludge had no technical basis
- Drum opening and waste segregation using excavator end-effectors resulted in high levels of airborne radioactive contamination within the Retrieval Enclosure.

In response to these lessons learned, equipment and procedures for completing Accelerated Retrieval Project removal actions were modified. Immediate modifications to operating equipment and procedures include (1) provisions for opening intact waste drums in the packaging glove boxes and (2) using electrostatic precipitators to limit transport of airborne contamination back into the Retrieval Enclosure. In addition, several modifications to the technical approach for possible future removal actions are being implemented, including use of hand-held detectors for semiquantitative analysis of waste samples to assist in identifying targeted waste types. These modifications are collectively referred to as the Targeted Waste Removal and Disposition Project concept.

The Targeted Waste Removal and Disposition Project concept for enhancing possible future removal actions includes the following features, previously used during retrieval at Rocky Flats Plant:

- Intact drums will be opened at a manned sorting table within the Retrieval Enclosure. The sorting table will incorporate local air-handling equipment to reduce airborne radioactive contamination and shielding to reduce worker exposure during waste handling. This approach requires workers to regularly occupy the Retrieval Enclosure.
- A photoionization detector will be used to discriminate between inorganic sludge and organic setup sludge by qualitative analysis of VOCs in samples removed from suspect drums before opening and waste segregation.
- A low-energy gamma ray spectrometer will be used to discriminate between highly contaminated Series 741 and less contaminated Series 742 waste water treatment sludge.
- HEPA filters, uranium roaster oxides, and graphite will be targeted using visual criteria.
- Targeted waste will be transferred from the sorting table to the Drum Packaging Station for visual examination and waste packaging.
- Nontargeted waste will be removed from the sorting table and returned to the pit.

### 3.1.6 Beryllium Reflector Block Grouting

Major sources of beryllium reflector waste buried in the SDA originated from three reactors in RTC: Advanced Test Reactor, Engineering Test Reactor, and Materials Testing Reactor. The buried beryllium waste consists of 20 reflector blocks from Advanced Test Reactor Cores 1, 2, and 3; nine outer shim control cylinders from Advanced Test Reactor Cores 1 and 2; and one beryllium reflector assembly each from the Materials Testing Reactor and Engineering Test Reactor. A total of 4,742 kg (10,454 lb) of beryllium was buried in the SDA from the reactors at RTC (Sebo et al. 2005). Beryllium waste is of special interest because it contains approximately 19% of the total C-14 inventory in the SDA. Beryllium exposed to moisture corrodes relatively rapidly, releasing C-14. Carbon-14 inventory in buried beryllium reflector waste comprises about 90% of releasable C-14 in the SDA. The remaining 81% of the total C-14 is in stainless steel and other alloys that corrode at a much slower rate than beryllium (Lopez and Schultz 2004).

The beryllium waste was grouted in situ in 2004 as a non-time-critical removal action under CERCLA, with concurrence of DEQ and EPA, to isolate beryllium and reduce infiltration of water, thereby, reducing corrosion and the corresponding release and migration of C-14 (Lopez et al. 2004). Burial locations of beryllium reflector waste were initially determined using original disposal records. However, reported disposal locations are probably not exact because disposal records are incomplete and end markers were disturbed after their original placement. Tritium surveys helped locate beryllium waste more precisely because tritium in the beryllium waste, as a result of neutron radiation, is released into soil through corrosion as a gas or water vapor. Geophysical surveys also helped locate beryllium waste by identifying metallic objects known to be buried close to beryllium disposal locations (see Figure 3-17), thus connecting current ground locations with reported historical locations.

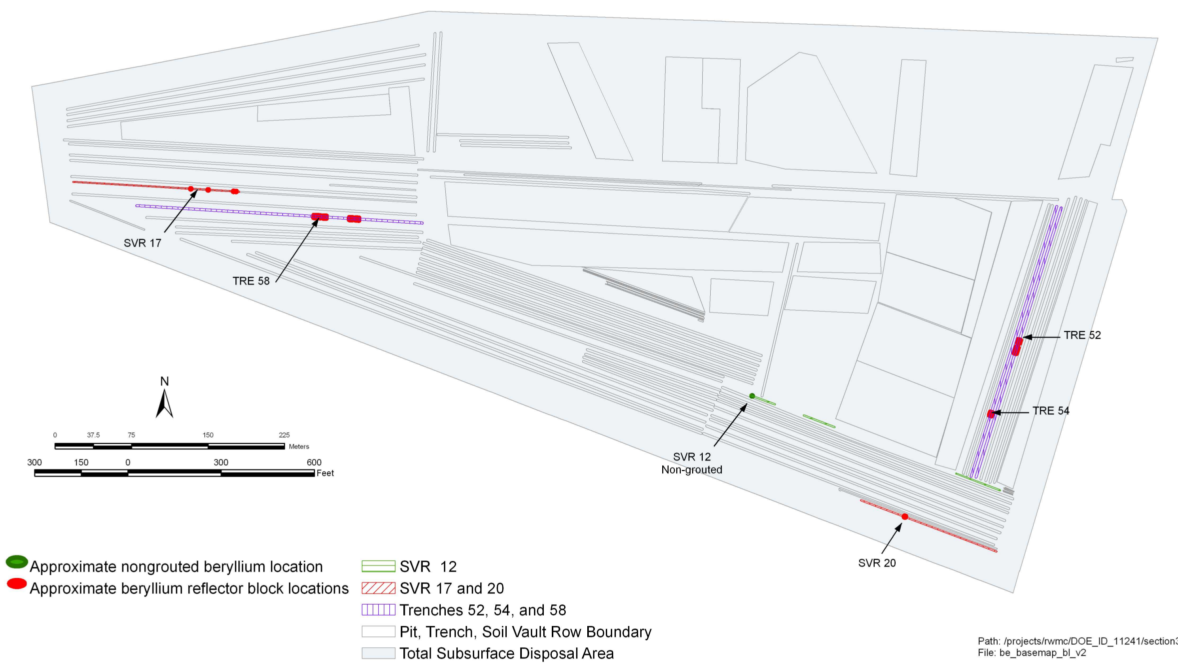


Figure 3-17. Approximate locations of beryllium disposal at the Subsurface Disposal Area.

A total of 15 locations were grouted using WAXFIX, a proprietary paraffin-based grout. Results of the evaluation of various grouts that led to selecting WAXFIX can be found in Hanson et al. (2004). Four locations in Trench 52, one location in Trench 54, five locations in Trench 58, four locations in SVR 17, and one location in SVR 20 were grouted (see Figure 3-17). A grout containment unit (i.e., an open steel box with a welded top plate and support feet bolted to the sides) was centered over the highest tritium reading associated with each disposal location. Trench containment units were 3.8 m (12.5 ft) long and 3 m (9.8 ft) wide, with forty-two 7.6-cm (6-in.) holes for the drill rod to penetrate. The SVR containment units were 3 × 3 m (9.8 × 9.8 ft), with nineteen 7.6-cm (6-in.) holes. The holes were generally arranged on a triangular pitch with 53.3-cm (21-in.) centers. The size of the containment units was chosen to cover the disposal locations adequately. Holes were drilled 7.6 m (25 ft) deep or to refusal (defined as 2 minutes of drilling with no penetration). When the prescribed depth was reached, subsurface columns were constructed by preprogrammed jet-grouting. Grouting was terminated below the surface to minimize grout returns. Containment units were then filled with a self-leveling cementitious grout to reduce subsidence and were covered with 61 cm (2 ft) of clean soil for shielding and insulation.

Effectiveness of the grouting action depends on accuracy of the grouting locations and effectiveness of waste form stabilization. The combination of disposal records and survey results provides a high level of confidence that locations grouted did contain beryllium waste. Although monitoring data are required to assess long-term effectiveness, the behavior of grout returns (i.e., initial holes had relatively small amounts of returns compared to later holes) can be interpreted to mean the grout was filling voids in the matrix beyond the nominal column. Returns increase when all of the voids in the waste have been filled. In addition, previous experience with in situ grouting demonstrations indicates that when grout returns come to the surface during injection, either the waste zone is fully saturated or grout injection is in undisturbed soil instead of an area containing waste.

An additional probable beryllium waste location, which was not included in the removal action, was found after the grouting action and has been confirmed by tritium surveys. This beryllium waste is in SVR 12 and is likely to be Advanced Test Reactor Core 2 reflector blocks buried in 1982. Approximately 89.7% by mass (4,254 of 4,742 kg) of the beryllium from the Advanced Test Reactor, Engineering Test Reactor, and Materials Testing Reactor was grouted. Table 3-14 compares the activities of C-14 and selected TRU isotopes in the grouted and ungrouted beryllium at disposal (Sebo et al. 2005).

Table 3-14. Comparison of isotopic activity in grouted and ungrouted beryllium.

| Isotope | Grouted (Ci) | Ungrouted (Ci) | Total (Ci) | Activity Grouted (%) |
|---|---|---|---|---|
| C-14 | 8.66E+01 | 5.83E+00 | 9.25E+01 | 93.69 |
| Np-237 | 1.36E-05 | 1.17E-06 | 1.47E-05 | 92.05 |
| Pu-238 | 1.26E+00 | 5.60E-02 | 1.31E+00 | 95.73 |
| Pu-239 | 1.34E-01 | 1.51E-02 | 1.49E-01 | 89.85 |
| Pu-240 | 2.15E-01 | 2.50E-02 | 2.40E-01 | 89.57 |
| Pu-242 | 5.09E-03 | 3.61E-04 | 5.45E-03 | 93.38 |
| Pu-244 | 1.03E-08 | 3.00E-10 | 1.06E-08 | 97.17 |
| Am-241 | 5.97E-01 | 5.82E-02 | 6.55E-01 | 91.11 |
| Am-243 | 6.65E-02 | 3.51E-03 | 7.00E-02 | 94.99 |
| Cm-243 | 2.06E-02 | 1.35E-03 | 2.20E-02 | 93.85 |
| Cm-245 | 3.74E-03 | 5.33E-05 | 3.79E-03 | 98.59 |
| Cm-246 | 1.27E-02 | 6.13E-05 | 1.28E-02 | 99.52 |
| Cm-247 | 1.39E-07 | 2.50E-10 | 1.39E-07 | 99.82 |
| Cm-248 | 3.16E-06 | 1.67E-09 | 3.16E-06 | 99.95 |